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# Air Quality and Animal Agriculture

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# Air Quality and Animal Agriculture

**Iowa State University Extension**
**College of Agriculture**
**College of Veterinary Medicine**

*To help relieve air quality concerns coming from livestock systems*

## Background

Air quality and potential gaseous emission from animal feeding operations (AFOs) are a concern among Iowans. Rural residents are concerned with odors and emissions from AFOs that may affect their health, property values, and the environment. Livestock producers are concerned with possible effects on their own family members and employees, the environment, and the health and productivity of the livestock.

## Objectives

Iowa State University Extension, the College of Agriculture, and the College of Veterinary Medicine are dedicated to serving the needs and concerns of Iowans through research activities, demonstrations, and educational programs related to air quality. Objectives of the air quality research and education programs include:

- identifying odorous compounds in manure and effects on humans and animals;
- measuring emissions from AFOs and impacts of downwind movement of these emissions;
- determining economic impact of emission mitigation practices and air quality regulations on livestock producers;
- determining economic impact of air quality concerns on neighborhoods;
- developing tools to measure and evaluate air quality impacts on the environment;
- providing unbiased information to the livestock industry, policymakers, and the general public on issues such as odor and dust emission practices: and
- providing tools to the livestock industry to use when siting new AFOs to reduce impacts on surrounding neighbors and communities.

## Research Accomplishments

From 1995 to 1999 just over one million dollars in funds supported air quality research at Iowa State University. These research projects have contributed to understanding: the dietary manipulation and management effect on odors emanating from manure; the impacts of bacteria and other microbial action on odor production and reduction; movement of dusts and gaseous emissions from livestock facilities; facility design management and ventilation strategies for reducing dusts and gaseous emissions; odor mitigation strategies; and the development of methods by which to scientifically measure odor.

***Odor Mitigation***:

A series of odor mitigation technologies were reviewed to determine effectiveness of these technologies in reducing odor from AFOs. These technologies included pit covers, biofilters, aeration, pit additives, injection, anaerobic digestion, composting, solids separation, and

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landscaping. The most promising of these technologies includes the pit covers, biofilters, and injection of manure. Overall, the research showed that not any one technology solved the odor issue, but that the use of a combination of technologies combined with good management could significantly reduce odor and gas emissions from facilities. Additional information related to these technologies can be found at: http://www.extension.iastate.edu/airquality/pubs.html.

***Measuring Odors***:

In the early 1990s our faculty pioneered the effort of developing a dynamic range olfactometer that was subsequently granted a U.S. patent and has facilitated the birth of a new generation of olfactometers that is being widely used by researchers across North America to quantify odors. The working principle of the olfactometer includes adding known amounts of odorous air to known quantities of fresh air in progressively increasing amounts until a carefully screened odor panel detects the existence of a foreign smell. The ratio of fresh air volume to odorous air volume is referred to as the odor dilution ratio (ODR). The higher the ODR, the more concentrated the odorous air. Today, more than 50% of animal-feeding operation related odor samples in the United States are measured using this technology at the ISU Olfactometery Lab.

## Current Research Initiatives

The focus of current research initiatives at Iowa State University builds on the work of past accomplishments. Areas of current research include: quantification of source emissions, air dispersion modeling to predict effects of AFOs on neighboring residences, and diet manipulation to control emissions.

***Quantification of Source Emissions***:

ISU researchers are working, independently and collaboratively with colleagues at peer institutions, to measure the amount of emissions of gases, particulates, and odors from selected AFOs that employ different housing and management schemes. Although limited in scope (i.e., number and type of facilities, and animal species), the studies will yield results that will enhance or fill gaps in the inventory database on AFO emissions. The studies also will reveal certain production practices or strategies that lead to reduced emissions. It should be noted that measurement of emission rate or amount requires the knowledge of both concentrations of the substance under concern and air exchange rate through the source. Accurate quantification of air exchange rate under commercial production conditions has been proving challenging and costly. Alternative technologies for measurement of air exchange rate are being developed, evaluated, and used in the emission studies.

***Air Dispersion Modeling***:

The goal of modeling is to predict the collective effects of a single or multiple AFOs on neighboring residences. The model is designed to allow either the producer, or his/her neighbors, to estimate the effect of adding another animal production facility in the neighborhood. The model predicts the impact of a facility on any neighbor in any direction and at any distance within a predefined geographic region based on facility type and size, the number, direction and distance of other facilities, geographic location within the state, and odor control technologies to be used.

The model adds the impacts from all the AFOs around a specific residence, no matter what the direction and or distance, so effects from different operations can be assessed as a total. The model, *Community Assessment Model*, will estimate the percent of time the selected residence will

experience odor of different concentrations. The model, while developed to address factors in Iowa, is still being calibrated and verified.

***Diet Manipulation***:

Although odors have always been associated with animal production, only recently has the interest to control odor using dietary strategies resulted in extensive research. Because minute changes in odors are difficult to measure, this research has resulted, primarily, in suggestions as to what may work. What is known is that odors are predominantly the result of anaerobic fermentation of feed waste, undigested feed, and secretions by the animal. Protein-derived odorants include skatole and indole and malodorous sulfur-containing compounds. Carbohydrate and protein-derived volatile fatty acids are thought to be major players in odor sensation as well. Feed waste is a major contributor to waste carbohydrates and may be a substantial source of volatile fatty acids and methane.

Feed wastage should be minimized. About half the waste protein is from indigested feed, the remainder resulting from animal secretions. Selection of easily digestible feedstuff can lower both the secretions by the animal and indigestible feed. Low-protein feeds also have been shown to reduce both odor and ammonia emission without compromising animal performance. An indirect method for reducing odorants is through manipulation of the microflora in both the intestines and in the waste. However, our understanding of how to manipulate the microflora is still rudimentary. In addition to reducing dietary crude protein content, other options to consider that can impact emissions include improving diet digestibility through feedstuff selection or use of compounds or enzymes that improve digestibility and reducing excreta pH through dietary mechanisms.

Recent projects have included evaluation of manure and odor effects from including co-products in swine diets. A current project assesses the effects of including amino acids (lysine, methionine, threonine, and tryptophan) on ammonia emissions from swine housing. Some commercial products will be studied as part of this project as well. Facilities are under construction that will allow for intensive evaluation of dietary manipulation on emissions from swine, poultry, and cattle. This lab is expected to be operational in summer 2003.

Future research initiatives have been discussed as a result of impending legislation and the increase in public awareness regarding animal feeding operations and air quality.

## Future Research Initiatives

***Evaluation of Emissions Instrumentation/Protocols***: Preparation is underway to develop and evaluate emission measurement instrumentation and protocols. Specifically, a portable, affordable and reliable field emissions sampling system will be developed and evaluated. Such a sampling system, upon successfully being developed and validated, would enable the end-users (researchers, auditors, producers) to reliably and conveniently collect source or downwind air samples for accurate measurement of the emission levels. The operational performance of some alternative, commercially available measurement instruments will be compared with that of more sophisticated counterparts under lab and field conditions.

***Quantification of Odors***: New air quality initiatives also include quantification of odor intensity level

(OIL) concurrent with that of ODR. OIL measures the degree of offensiveness of an odor. An air quality sample may share the same odor strength or ODR, but it could have drastically different OIL levels.

As funding becomes available, the scope of current emission studies will be expanded to include more production facilities and thus management styles, animal species and geographical locations to strengthen the emission database. Finally, and perhaps most importantly, future research will continue to evaluate and identify practical emission mitigation techniques that can be adopted by the livestock industry.

For a list of research reports, extension publications, and links to current news regarding air quality and animal agriculture, please visit the Air Quality and Animal Agriculture Web page at: http://www.extension.iastate.edu/airquality.

## Resources

A fact sheet, *Air Quality Resources for Iowa Animal Agriculture*, contains a list of air quality resources and extension publications available for distribution. This fact sheet is available through Extension Publications Distribution and may be ordered by calling (515) 294-5247. Please reference PM 1936 when ordering.

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